



Fermilab

Closeout Presentations

Director's

Follow-up CD-2/3a Review

of

the NOvA Project

August 21-22, 2007

08/22/2007

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Executive Summary

Technical

The NOvA Project Team presented material supporting a proposed project technical, cost, and schedule baseline to design and construct a 15 kton detector for a NuMI Off-Axis electron neutrino Appearance experiment. This was downsized from their 18 kton proposal made during the June NOvA Director's CD-2/3a Review.

Cost

A tremendous amount of effort was invested since June to 1) correct errors in the resource loaded schedule (RLS) that had just been completed shortly before that review, 2) identify, examine, and select several cost saving measures, and 3) reduce the detector volume to 15 kton in order to hold the cost to \$258.9M, which is less than the \$260M OMB ceiling. This effort was described and summarized in an overview presentation by the Project Manager. The Project Scheduler described the steps that had been taken to create this new RLS in another summary presentation to the committee before we moved on to six parallel breakout sessions to investigate in more detail the technical, cost, and schedule aspects of the new proposal. These breakout sessions continued into the afternoon with the addition of a Cost, Schedule, and Management breakout session.

The Committee found there was a comprehensive, self-consistent, design supported by a nearly complete, documented, reviewable, and credible cost/schedule plan (CSP). The NOvA Project Team is continuing their efforts to scrub and improve the RLS. During the breakout sessions the Review Committee interacted with the L2 Managers and NOvA project team to examine the modified technical design, the bases of estimate (BOE), the consistency between the BOE and the RLS, the durations of the scheduled activities, and the soundness of the cost and schedule estimates. These were all generally found to be well developed.

Schedule

The RLS has been created using the Open Plan scheduling package. The cost roll-ups were done using the Cobra software package fed by the Open Plan output. This is a powerful set of project management tools and will form a good basis for the NOvA EVMS system as found in the June joint Fermilab/DOE Performance Management System Review.

Due to the amount of effort and time it took to get to this stage of developing the revised RLS, there was not time to perform the iterations required to fit the NOvA obligations profile under the funding guidance profile. This must be accomplished prior to submission of documentation for the DOE CD-2/(3a) Review.

Management

The NOvA Project management is to be congratulated for getting to this advanced stage of development. However, significant additional effort is required to complete preparations for a DOE CD-2/(3a) Review.

1.0 Introduction

A Director's Follow-up CD-2/3a Review of the NOvA Project was held on August 21-22, 2007. The charge included a list of topics to be addressed as part of the review. The assessment of the Review Committee is documented in the body of this closeout presentation.

Each section in this closeout presentation is generally organized by Findings, Comments and Recommendations. Findings are statements of fact that summarize noteworthy information presented during the review. The Comments are judgment statements about the facts presented during the review and are based on reviewers' experience and expertise. The comments are to be evaluated by the project team and actions taken as deemed appropriate. Recommendations are statements of actions that should be addressed by the project team. Progress on the recommendations is to be reported on during future NOvA Working Group Meetings (WGMs). A response to recommendation(s) is expected and actions taken will be reported on during future reviews.

2.0 Accelerator NuMI Upgrades (WBS 1.0/2.0)

Primary Writer: Alireza Nassiri

Contributors: John Maclean

Findings

- The scope of the accelerator upgrade of the NOvA project is to increase the beam power of the 120 GeV beam from the Main Injector (MI) onto NuMI target to 700 kW.
- The ANU beam builds upon existing machines, the existing accelerator complex consists of Linac, Booster, and Main Injector, the NuMI beamline, and the proton plan. ANU combines these and adds Recycler, to increase proton beam power.
- The Main Injector (MI) today provides, 120 GeV proton beam with roughly 270 kW (80 kW for antiproton production and 190 kW for neutrino production). MI takes 6 to 7 batches from the 8 GeV Booster at 15 Hz repetition rate with $\sim 5 \times 10^{12}$ protons for a total cycle time of 2.4 s
- Recently more than 4×10^{13} protons in a pulse, giving a resulting total beam power of 325 kW have been achieved.
- The upgrade will build on the “Proton Plan” with the goal of increasing beam power to 320 kW to MuMI and 80 kW to anti-proton, for 400 kW total. The increase of proton throughput of the Main Injector (MI) will be achieved by utilizing the Recycler Ring (RR) for slip-stacking 12 proton batches from the Booster with the MI cycle of 1.333 sec.
- Slip-stacking of 11 Booster batches in the MI has been demonstrated with good efficiency of about 92%. The beam losses are below 3% including beam loss during injection front porch.
- With the installation of the gap cleaner kicker and the collimators only the injection front porch beam loss is uncontrolled. This is in line with the design goal for the NOvA upgrade.
- The project responded to recommendations from the Director’s CD-2/3a Review of NOvA Project in June 2007. The responses were summarized in Appendix H with title, “Table of Recommendation for the Director’s CD-2/3a Review of the NOvA Project, June 4-6, 2007.” The project provided responses to four accelerator related recommendations that were considered to be related to NOvA. The recommendations, the responses, and our comments on the responses are below.

1. Include complete system integration testing in the scope of the project.

Response: Done. We systematically reviewed each system, examined whether pre-beam testing was included, and updated systems accordingly.

Comment: The recommendation has been followed.

2. Complete the conceptual design as soon as possible and then review the contingencies used in the engineering designs.

Response: Done. Contingencies have been reviewed throughout ANU as the design stands today. Design work is continuing and contingencies will be revised again as appropriate.

Comment: The recommendation has been followed. We concur with the project team. We strongly encourage on-time engineering designs revision and update.

3. Consider installing the prototype gap cleaner or the final magnet built early in the MI for early testing and use by NuMI. The gap cleaner can later be moved to RR.

Response: Done. The gap cleaning kicker system has been moved off-project and will be developed for ASAP installation in the MI.

Comment: The recommendation had been followed. We believe this is an important test and crucial to the project. We encourage AD management to provide necessary resources to do this task ASAP.

4. Consider minimizing beam losses in the Recycler as part of the design efforts.

Response: Done. Minimizing beam losses in part of the design efforts through simulations and studies of slip-stacking effort in MI. Most of the losses in the Recycler come from beam in the injection kicker gap. We plan to build gap cleaning kickers to take care of this loss. In addition the loss monitors in MI and the MI-8 loss monitors (mainly the ones close to the collimators) will be used to protect the Recycler from bad quality beam pulses from Booster.

Comment: The committee is satisfied with the project response.

Comments

- A major concern for the accelerator upgrade portion of the project is “off project” items. In particular access to staff resources when required could prove to be a schedule problem. We encourage project management draw up contingency plans for bringing in external resources if required. This could be locating sources of contract staff, seeing if it is possible to “rent” people from other labs or assembling work packages that can be placed with external contractors.
- The technical risk of hardware components outline in WBS 1.0 /2.0 is small. The overall level of contingency throughout this WBS is reasonable. Items that require R&D have justifiably higher contingency as result of not having design frozen.

The project should finalize the conceptual design as soon as possible and then review the required contingency of the engineering designs. Engineering design of the new 53 MHz RF is an example of such effort.

- The main risk is the control and handling of the beam losses in the MI and RR with the higher proton throughput. The recent success of 11 batch slip-stacking produced greater than $1e13$ proton and a cycle efficiency of ~94%, which is approaching ANU goals. We are very encouraged by this result. The part of the beam loss that would be uncontrolled when the gap cleaner and collimator are installed in line with the design goal for the NOvA upgrade.
- The success of the NOvA: 700 kW beam power upgrade is heavily dependent on the success of the preceding “Proton Plan” upgrade. The NOvA project team plans to follow the progress of the proton plan and perform realistic simulations and target tests at the MI.
- We are concerned about the schedule for the development of the Recycler five kicker systems. The kicker systems seem to be very close of being on the critical path. We encourage the project team to revisit the Recycler kicker systems schedule to minimize their impact on the project. On-time construction of the planned service building for the kicker systems including water cooling system is crucial. We strongly encourage Laboratory Management to take all necessary measures to make it happen.
- We reviewed the concerns expressed by the previous review committee regarding the Ti or TiN coating of the inside of the ceramics to suppress secondary emissions of surface electrons. The project team chose to use Graphitic carbon instead. SEY data reported by SLAC (SLAC-PUB-8212) seems to suggest that Graphitic carbon is as effect as TiN in primary beam energy range of 400 to 500 eV. We don’t consider this to be an issue. We encourage the project to conduct basic resistivity test and measurement after coating.
- We are encouraged to see a plan for prototyping two full cleaning gap magnets and power supplies. These will be “bench” tested at full power. Test and measurement results will be used to make modifications if necessary.
- We reviewed the basic conceptual design of the 53 MHz cavity for the Recycler Ring (RR). The project L3 and L4 Managers responsible for this task presented their plan for design and construction of three new cavities (2 +1 hot spare) with four PA systems. We believe the in-house approach to fabrication and assembly has a minimum risk. The technical team available to the project is fully capable to carry out this task.
- We learned the LLRF system for the RR new cavities will be exact duplicate of the existing MI LLRF system. We agree that if the amplitude and phase control requirements and performance are adequate, then this approach is sound and will eliminate R&D effort for LLRF development.

- We performed WBS drill-down exercises in three areas:

Drill down #1: 53 MHz System (WBS 2.0.1.1.2)

- Three new 53 MHz cavities for slip stacking (6+6 Booster batches) are planned to be built. Two will be part of operation and the 3rd unit will be installed in RR as “hot- spare.” A conceptual design is completed. All fabrications and assemblies will be done in-house. Tetrodes will be purchased from a vendor that has a current contract with the Lab. The LLRF RF system for this is mainly a duplicate of the MI LLRF system. We discussed the BOEs and RLS with L3 and L4 managers. We believe the cost, schedule, and contingency for this WBS is reasonable.

Drill down#2 RR Injection and gap clearing kickers (WBS 1.0.2.1.1)

- A prototype kicker is being built under WBS 1.0.1.2.1. The final kicker will be built under 2.0.1.2.1 with power supplies being built under 2.0.1.2.2. The total cost of the kicker systems is about \$8M including power supply. We looked at BOE and examined various entries related to this WBS. We did not find discrepancies for this particular entry. The BOE tables were consistent.
- The project is planning to build prototypes of a number of kickers including the gap clearing kicker. We concur with the previous reviewers that gap clearing is very important and NuMI and NOvA would benefit from installation of a gap clearing system in the MI. For the long-lead items such as ceramic beam chambers, the plan is to purchase now using Fermilab operating money. They will be test and put aside as spares. The project will buy the spares using project funding when they are needed. The design of the kickers is such that they all will use the same cross section chambers.

Drill down#3 NuMI Target Hall Infrastructure (WBS 1.0.1.2 / 2.0.3.3)

- These WBS items were selected for drill down as they were relatively “big ticket” items in the WBS. The reviewer spoke to the L3 PM. The PM had a good understanding of his area of the project.
- Fermilab staff has experience of moving horn2 to the work cell for maintenance activities. This is a good indication that areas of the schedule dealing with the handling of horn2 and dealing with its immediate environment should have a high confidence factor as to their accuracy.
- Generally the BOE documents were good, with a good level of detail. Assumptions and uncertainties were documented. Estimates seemed to have a good basis, usually from vendor estimates or previous experience and occasionally engineering estimates. We did not encounter any WAGs.
- Overall we are concerned that this WBS item is relying on lab resources outside of the projects control. For example, the allocation of mechanical engineers and designers. This could cause schedule problems if not carefully managed. It will be

essential that lab management is aware of resource requirements, and changes to those requirements as far ahead as possible.

- Doc# 1767:
 - There is a lot of contingency allowed for space planning. This is clearly a situation where pre-planning work is required. Since this work has not yet been done the contingency allowance is sensible. We encourage this planning be performed as early possible as this is an easy way to remove uncertainty from the project.
 - It is not anticipated that any show stopping issues will arise.
- Doc# 1700, UID 1488, UID2534
 - On the small number of tasks we drilled down to, sufficient reviews appear to have been planned. Management seem to be involved with reviews as appropriate and the PM expected to bring in external reviewers where needed.
 - The plan for using 50% scraps steel for the new T blocks seems to be a sensible one in a number of ways. It should reduce overall costs, may recycle some scrap Fermilab steel and is a way of insulating the project from fluctuations in steel price. We did not see documentary evidence that the 50% level was available but it seems that a greater quantity may be available, in which case the 50% figure seems reasonable.
 - Cooling for the NuMI tunnel will rely on new chillers being installed during this shutdown. Although this is an off project activity the risk to the project seems small in this case.

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Recommendations

1. We recommend project to hold an external (to the project) design review of the Recycler 53 MHz RF system after the internal final design of the 53 MHz rf systems is completed.
2. We recommend project to hold an external (to the project) design review of the RR injection, MI injection, and RR abort kicker magnet systems.

3.0 Farsite Building (WBS 1.1/2.1)

Primary Writer: Karen Hellman

Contributors: Jeff Sims

Findings

- The project has received three independent cost estimates and construction phase schedules for the site and building construction. The cost estimates have been standardized for comparison purposes. Monte Carlo analysis has been utilized to perform analysis on the estimates and finalize the building cost estimate.
- A drill down on the Open Plan schedule revealed that previously identified inconsistencies between Open Plan and the Basis of Estimate data book have been corrected. No new discrepancies were found.
- Contingency values have been developed based on the teams current understanding of design uncertainties, estimate uncertainties, identified risks and unknown conditions. The aforementioned Monte Carlo analysis provided input on the estimate uncertainty portion of the contingency value by understanding the spread of expected costs. The contingency values are risk informed because the team utilized the risk expected values to determine the contingency needed for identified risks.
- Escalation rates were developed based on input from three consultants. The average of the three suggested escalation rates were used for civil construction elements. These escalation rates exceed the DOE recommended values used for civil construction.
- The team has completed a significant value engineering exercise which resulted in cost savings of approximately \$1.6 M on the building.
- A risk list and evaluation has been prepared and includes 27 items. These items have been evaluated for cost impact, which forms the basis for a portion of the contingency assignments.
- The project has developed an excellent option for wetland banking. This appears to be a low-cost opportunity to manage the mitigation of wetlands needed by the project.

Comments

- A 2nd draft of an MOU between the NOvA Project and the University of Minnesota exists but is not complete. The project expects to have a completed version signed by Marshak and Cooper before Oct 1 (other signatures may be in progress at that time). The Cooperative Agreement calls for this MOU to be complete within 60 days of the start of the CA. Start of the CA is currently thought to be about Sept 1.

- The Environmental Assessment process has begun but is not yet complete. The EA has been prepared to include the work for the Ash River site and the work planned at Fermi Lab. The EA will require public review by Illinois, Wisconsin and Minnesota. This document should be finished and sent out for comment as soon as possible. It is our assumption that the decision on the Environmental Assessment must be complete prior to initiation of work on either site.
- Activities required to support the requirements of CD-3a include successful completion of the Lehman review, followed by an External Independent Review (EIR date to be determined), and finally the ESAAB approval. These activities should all be included in the project schedule.

Recommendations

- None

4.0 Scintillator/Fiber/PVC Extrusions (WBS 1.2/2.2, 1.3/2.3 & 1.4/2.4)

Primary Writer: Linda Stutte

Contributors: Joe Ingraffia

Findings

- The Basis of Estimate documents for all commodities were extensive, and were based on reasonably current vendor quotes.
- Major changes to the commodities since the last review were due to the reduction in tonnage of the detector. Fiber and PVC extrusions had smaller quantities as did scintillator. Because a cost-reduction decision was taken to use 75% fluors, the number of suppliers of mineral oil was reduced to a single acceptable vendor since a larger attenuation length was needed to accommodate this reduction. The mineral oil cost is not dependent on attenuation length, however, and additional vendors are being pursued.
- All Level 2 managers had risk assessments. Larger risks were found to be:
 - Scintillator: Single supplier of wave shifting material.
 - Fiber: Single supplier of fiber, possible cost increases due to failure to obtain a waiver for import duty, expiration of the current quote, fluctuation in the exchange rate.
 - PVC extrusions: Die needs to be re-built (~4 month delay), density higher (more material needed)
- Indirect costs were spelled out in the Basis of Estimate documents for fiber, but not scintillator or PVC extrusions.

Comments

- Three recommendations were made at the last review. All three were addressed.
 - Scrub costs and schedules – Done. Only 1 document found that needed updating during drilldowns.
 - Develop standard procurement milestone plan for the commodities – Done. One minor change needed for fiber was noted during the drilldowns.
 - Use current pricing for mineral oil. – Done.
- The cost and schedule documents for the PVC extrusions were organized differently from those for fibers and scintillator, but this seemed reasonable, given the different nature of the commodities.

Recommendations

3. A common method of addressing indirect costs needs to be adopted across all three commodities for the Basis of Estimate documents.

5.0 PVC Modules (WBS 1.5/2.5)

Primary Writer: Alan Bross

Contributors: Heidi Schellman

Findings

- The basic design of the extrusion module has not changed since the last review although there have been some minor updates to some of the parts in the module.
- We reviewed the status of our recommendations from the last review and all have been put in place except one – *“Prototype and test as soon as possible the baseline method (packed desiccant) for insuring that the sealed gas volume surrounding the APD (interface region between the APD module and the PVC module optical connector) remains dry and prevents any possibility of condensation on the APD or fiber surfaces”*. This work is actively being investigated (in collaboration with project team 2.6), but a conclusion has not yet been reached. Previous technical concerns about glue seals at the bottom ends have been addressed and increased automation for the gluing procedures has been adopted. [Note: We recommended fully automation of glue application for the end seal. Their solution is partial automation with some manual labor. We feel that this scenario is acceptable.]
- The Level 2 manager has completed the Risk Assessment and appropriate contingencies have been identified. We discussed critical path items in some detail - the incoming and outgoing buffers of materials and assembled modules give them several weeks of protection from failures on delivery to and from the factory. They can go to weekend shifts if they fall behind.
- All BOEs have been completed for this WBS and the numbers are consistent with the resource loaded schedule. Time and motion studies have been done for approximately 80% of the tasks which is as far as the team can take it before the final equipment is purchased and the factory setup.
- We found one instance in the schedule where a two-week vendor bid period spanned the Christmas Holiday. Although the project software did add an additional week, this looked optimistic.

Comments

- The committee again commends the PVC module team on the excellent work they have been doing. In particular their technical, project, and cost plans are well-developed and defensible. We feel that they are ready for the Lehman Review.
- Note: Binders with BOE's indexed by the WBS numbers are very useful.

Recommendations

4. Review schedule regarding vendor bid periods. Some additional time in at least one case is warranted.
5. Resolve the fiber/photodetector environment issue (dessicant issue) as soon as possible.

6.0 Front-end Electronics and DAQ (WBS 1.6/2.6 & 1.7/2.7)

Primary Writer: Jonathan Lewis

Contributors: Eric Gottschalk

Findings

- At the June Director's Review, we found the FE/DAQ elements to be on a good technical footing. There has been good progress since then.
- A risk assessment has been completed
- The schedule still needs further work:
 - Some items do not have predecessors
 - Some items have inappropriate predecessors
 - Some items do not have successors (e.g. review 2.7.2.1)
 - Most items did not have reviews prior to procurement
 - Some items were missing (e.g. install front-end boards on near detector, ship boards to Ash River)
 - The third Run Control release is called #4
 - Detector Control System completion (27. Nov. 2012) occurs after the planned end of NOvA construction.
 - The task called "Test APD Modules" includes both assembly and testing which should be reflected in the name.
- BOEs for labor items contain minimal information
- According to the schedule, the IPND (like the ISS) is completed, but never operated

Comments

- A single-page "project flow" diagram would be helpful to see dependencies on other subprojects, float for different parts of the subproject relative to key NOvA milestones, and the critical path for the subproject.
- Having M&S Obligation and Labor profiles would be helpful. We understand this was done for the CD-1 Review and should be prepared for the CD-2/3a Review.
- Having labor rollups (or summaries) would be helpful to see high-level summaries of labor for different parts of the subproject. This would also help to

see if and where "off-project labor has been included" in the WBS. This was a recommendation from the CD-1 Review

Recommendations

6. Include operation of the IPND with sufficient duration to qualify electronics. Include on-project operation labor as well as time for analysis which may or may not be in the project.
7. Include reviews of all significant components prior to production purchase. Review should follow IPND operation for most. Acceptance of review should be the milestone for completion of each R&D task and a predecessor to construction.
8. Further scrub the schedule to include missing items, such as predecessor and successor links, and missing labor on some tasks.
9. Scrub BOE documents to include more detail. For example, replace "previous experience" for labor items with more information on actual experience that the group has. Check that costs and contingencies have been properly copied from BOEs to OpenPlan.

7.0 Far Detector Assembly and Near Detector Assembly (WBS 1.8/2.8 & 2.9)

Primary Writer: Charlie Cooper

Contributors: Jerry Leibfritz

Findings

- The number of new blocks required for the Near Detector assembly decreased from 3 to 2 because all of the IPND blocks are now going to be used. Despite this reduction, the cost of the Near Detector Assembly increased 2.2M\$ since the last review. The increase is due primarily to the fact that originally there was no contingency included for excavation. The total cost of the Near Detector assembly is quoted at 7.9M\$ with 94% M&S contingency and 58% labor contingency.
- The cost of the Far Detector decreased 5.7M\$ since the last review, primarily because the North shield wall was removed and the number of blocks was reduced from 38 to 32.3. The total cost for the Far Detector assembly is quoted at 19.1M\$ with 60% M&S contingency and 84% labor contingency.
- There were 18 recommendations from the June 5th Director's CD-2/3a NOvA Review. Many of these recommendations had to do with BOE. All of the recommendations have been addressed or are in the process of being addressed through on-going studies. These include the close to full height block test with water and external expert review of the FEA analysis. Recommendation number 32, "Investigate ways to accelerate block-to-block interaction tests that depend on creep and/or creep induced buckling (elevated temperature)", was claimed to be too hard and expensive to do.
- A risk assessment has been done for sections 1.8, 2.8, and 2.9 and has been incorporated into the cost and schedule contingencies. Most of the Far Detector tasks had 100% labor contingencies prior to the risk analysis.
- The Near and Far Detector assemblies have the highest contingencies of the project, 90% and 72%, respectively.
- BOEs have been generated for all Level-4 WBS items and match the Resource Loaded Schedule.
- Approximately 80 Milestones have been generated for sections 1.8, 2.8, and 2.9.
- A hazard analysis has been done for some of the critical issues, such as methyl methacrylate vapors, static discharge from filling the scintillator material, and crushing/falling injuries associated with the block pivoter.

Comments

- There has been a great deal of good work done since the last review on developing BOEs, analyzing risk, and assigning contingency.
- All of the risks that were examined for the Near Detector were thoroughly thought out and had apparently appropriate contingencies assigned.
- Many risks were detailed for the Far Detector and corrective actions proposed. However, in the previous review, where no risk assessment had been done, the labor contingencies were already at 100%. These labor contingencies will more than likely remain at 100% until more time/ergonomic studies can be done. It is unclear how the risks were included in the labor contingencies, since these contingencies were already 100%.
- Recommendation 32 from the previous review stated that it would be too expensive and too time consuming to accelerate block to block interactions from creep. After some brief discussion it was stated that the task could be accomplished by increasing the deviation from vertical of the blocks.
- It was difficult to compare the BOEs to the Budget and Contingency because of the included overhead in the latter. Actually, the Gant chart had to be compared to the BOEs and then to the Budget and Contingencies. Including roll-up summaries in the Gant charts would make this process easier.
- One discrepancy on a BOE (1.8.5.3 IPND Equipment) was discovered out of the approximately 10 drill-down exercises that were conducted.

Recommendations

10. Continue to address the unresolved recommendations from the June 5th Director's CD-2/3a NOvA Review. Specifically address recommendation 32 by revisiting different ways to accelerate block to block interactions from creep (deviation from vertical)..
11. Continue with ergonomic and time studies to improve the labor estimate contingencies for the Far Detector assembly.
12. The BOEs and Resource Loaded Schedule should continue to be checked to eliminate any errors. Fix the discrepancy between the BOE and the Resource Loaded Schedule in task 1.8.5.3, IPND Equipment.

8.0 Cost, Schedule including Earned Value (EV) Setup

Primary Writer: Bill Boroski

Contributors: Fran Clark, Dean Hoffer

Cost

Findings

- The current estimate for the total project cost (TPC) is \$258.9M, with a contingency of \$58M (29% of TPC). The TPC now falls within the DOE guidance limit of \$260M.
- The current cost profile does not match the funding profile provided in DOE guidance. Projected project costs exceed the guidance profile by \$5.9M in FY09 and \$7.2M in FY11.
- Basis of Estimate (BOE) documents exist for most of the activities in the WBS and appear to be reasonably well-detailed, with an appropriate level of detail to support the cost estimate.
- Three of the six recommendations from the June review have been satisfactorily addressed. Good progress being made on the remaining recommendations, which include:
 1. A thorough and rigorous review of the new cost estimate;
 2. A review of the cost estimate to ensure that BOE documents are correctly matched to WBS line items and that BOEs contain the necessary information to support the cost estimate;
 3. A review of the level of contingency applied by L2 managers to ensure that NOvA contingency rules are being applied uniformly across the project.

Comments

- Total project cost is close to the cost limit. Detailed BOEs are critical in ensuring that the cost basis is well-documented and defensible.
- The project is making good use of DocDB to organize critical documentation. For example, supporting documentation for the BOE's is readily available and easily accessible (e.g., vendor quotes, supplier input, facility construction cost estimates, etc.).
- WBS drill-downs disclosed a few remaining discrepancies between cost estimates in the BOE documents and costs shown in the RLS. L2 managers should be encouraged to verify that costs shown in the RLS match those in the BOE documents.

Recommendations

13. Finish scrubbing the cost estimate in the resource loaded schedule to ensure that costs in the RLS match values in the Basis of Estimate (BOE) documents.
14. When developing the final version of the cost estimate from Cobra, allow sufficient time for review and vetting by project staff before the TPC is presented for DOE baseline consideration.

Schedule Including Earned Value (EV) Setup

Findings

- A detailed, resource-loaded schedule exists and is maintained by a full-time, experienced project scheduler. Responsibility for schedule accuracy has been delegated to L2 managers.
- Time estimates and task durations appear to be reasonable. They are based on input from vendors and suppliers, experience gained through R&D activities and the expertise of experienced project staff. The bases for schedule durations are well-documented in BOE documents.
- Four of the five recommendations from the June review have been satisfactorily addressed. The remaining recommendation involves scrubbing the schedule to ensure quality and consistency. The project office has been conducting a series of reviews with the L2 managers, with an emphasis on cleaning up the schedule (e.g., finding and correcting missing predecessors and successors, breaking up long-duration items, adding sufficient milestones, etc.). This work is expected to be finished by September 17.
- Schedule contingency currently exists in the form of buffered storage at vendor and production sites. For example, storage for 2-3 weeks of production output is planned for at the PVC extrusion vendor site. This allows buffering should there be a short-term problem with extrusion production.
- The project office acknowledges that they understand what needs to be done with respect to setting up for an earned-value tracking and management system, but that work still needs to be done on implementation.

Comments

- The project is in the process of updating the cost and schedule plan to accommodate earned-value reporting. The project is also in the process of addressing recommendations from the joint Fermilab/DOE Performance Management System review held June 19-20, 2007.
- Although much progress has been made to date, the committee has significant concern that the project office does not have sufficient resources to complete the final preparation of the project cost and schedule by the reported September 17 target.

Recommendations

15. Continue ongoing efforts to scrub the schedule to identify discrepancies between the RLS and BOE documents, clean up missing predecessor/successor links, and validate existing data. As part of the schedule refinement process, the project should also:

- Document the bases for leads and lags in the Open Plan “notes” field.

- Assign levels (0 through 7) to schedule milestones and vet them within the project. Establish schedule contingency for the high level milestones to set the completion date. Update milestone titles and add definitions that describe what constitutes milestone completion, where appropriate.
 - Revise the schedule so that the obligation profile meets the DOE-provided funding profile.
16. Follow through on Recommendation #7 from the June 19-20, 2007, Performance Management System Review. Namely, Control Account Manager (CAM) notebooks should be prepared and maintained in advance of the DOE EVMS assessment.
 17. Finish assigning Performance Measurement Techniques (PMTs) to construction activities and document how “% Complete PMT” will be earned.
 18. Seek additional resources to help the project office complete, review, and refine the project cost and schedule, and supporting documents, in preparation for the upcoming DOE CD-2/3a review.

9.0 Project Management (WBS 1.9/2.10)

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Findings

- An overview was given of the progress made since the last review and in preparation for the upcoming CD-2 and EIR reviews. The changes made to reduce the TPC to under \$260M were covered, and the project status in preparing for the 16 EIR LOI's was shown.
- The PPEP and PPMP needed for CD-1 were made available
- A single page master schedule with critical path was shown for the overall project.
- Formal change control is planned, but is not currently used.
- Earned value reporting is not yet implemented in monthly reports, which have been done for some time in narrative form.
- No draft MOU's or SOW's were shown to the committee. The CA with UM is in progress.
- The project office staffing is projected to be 9.1 FTE's in FY'08, and about that in FY'09-FY12, before ramping down substantially in FY13. There is no contingency on PO labor, but costs were included for external expertise for consulting or reviews.

Comments

- The project should be commended for their continued progress towards baselining the Nova project. The project team is a good one, and they have nearly all the tools in place to successfully manage the project. The Technical Design Report and other project management documents are largely complete, but will need additional efforts to complete the transition from an 18kT to 15kT baseline detector. Unfortunately, the review team was somewhat hindered in preparations for the review by many of the review materials only becoming available the evening before the review. This will probably not be acceptable for a DOE baseline review. The project team did an excellent job of answering the reviewer's questions.
- Getting the project scope in agreement with the overall funding limit is a major accomplishment. Not having the obligation and funding profiles in detailed balance is an obstacle to the committee declaring that the project has met all requirements needed to be ready for a baseline review. This needs to be completed soon, so that there is adequate opportunity for internal review prior to a

baseline review, and so that formal project controls and Earned Value reporting can begin to be used.

- Project planning depends on an MOU between Fermilab and the University of Minnesota which is being drafted. Fermilab, project management, University of Minnesota, and DOE roles and responsibilities, especially with regards to safety and contingency utilization, would benefit from such an MOU.
- It is important to put MOU's and SOW's in place soon. Understanding of the resources being planned on by the project, and committed by the collaborating institutions (including Fermilab) will avoid misunderstandings and put the project labor planning on more solid ground.
- The addition of an expeditor to the project office is a good idea, and should help with the large procurements. Having no labor contingency is a concern to the committee, especially in light of the difficulty in preparing all the material needed for a baseline review.
- The migration to WelcomRisk is a good move, and has been done.

Recommendations

19. There needs to be detailed balance of funding and obligations by FY before a baseline review.
20. It is important to have a draft MOU begun between Fermilab and the University of Minnesota to supplement the CA in place for the CD-2 review.
21. Begin to prepare MOU's and SOW's for all institutions planning on doing work for the project, so that responsibilities and labor resources commitments are clearly understood in advance of CD-2.
22. Upgrade both PEP and PMP prior to a baseline review.
23. Prepare a startup plan prior to a baseline review.
24. Create a change control flow chart and better document the change control process and associated record retention.
25. Complete the TDR and scrub all CD-2 related documentation to reflect the current project status and scope.
26. Increase the contingency in the project office labor.
27. Preparation of materials for the baseline review should be made available early enough that the reviewers have adequate time to prepare for the review.

10.0 Charge Questions

10.1 Has each L2 manager completed a Risk Assessment? Have mitigation plans been incorporated in the Cost and Schedule Plan (CSP) and / or have appropriate contingencies been identified?

Risk assessments have been completed by the L2 managers. Identified risks have been evaluated and ranked following criteria outlined in the NOvA Risk Management Plan. In nearly all cases, mitigation plans have been incorporated into the CSP at what appear to be appropriate and reasonable levels. However, there are a few areas in which contingency levels may need further refinement. For example, labor contingency remains at 100% for Far and Near Detector Assembly activities, pending the completion of block assembly time and motion studies. Also, labor contingency on project management is set to zero. This should be re-evaluated in light of the historical work load on the project office and the complexity of project execution.

10.2 Has the NOvA project adequately addressed the 16 lines of inquiry (LOI) items?

The project has addressed almost all of the 16 lines of inquiry, but not all are complete.

10.3 Have the Bases of Estimate (BOEs) been generated and completed? Do they match the Resource Loaded Schedule (RLS)?

Bases of Estimate (BOE) documents exist for nearly all activities in the WBS. In general, the BOEs are well-prepared, with an impressive level of detail and quick access to supporting documentation through the use of the DocDB database. Some effort is required to complete the remaining BOEs.

For those BOEs that do exist, there are some remaining discrepancies between the cost estimate in the BOE and the cost shown in the RLS. Additional work is required by the project office and L2 managers to identify and correct these discrepancies.

10.4 Has the schedule been adequately developed and is it ready to be baselined?

A detailed 6000-line schedule has been developed and continues to undergo scrutiny and review by the project team to improve accuracy and completeness. Although significant improvements have been made since the June 2007 Director's Review, additional work is required before the schedule is ready for baselining.

10.5 Is there a one page high-level schedule that depicts the critical path?

Yes

10.6 Does the obligation roll-up match the funding profile guidance? Is the cost profile from the baseline schedule consistent with the incurrence of actual costs in order to facilitate earned value management?

Not yet. The overall cost and funding match well, but the committee was shown a cost profile with large year to year differences between it and the anticipated funding profile.

During an offline meeting with the cost and schedule staff, it was learned that there is a plan in place to use change control to baseline payment schedules once procurement awards are made and to collect appropriate information prior to month close in order to accrue cost. This plan will satisfy the concern expressed during the EVMS review.

10.7 How is NOvA doing at addressing recommendations from the Director's CD-2/3a Review that are needed for Baseline Development?

The NOvA team is doing well at addressing all of the questions from the Directors CD-2/3a Review. They have responded well to those that are needed for Baseline Development

10.8 How is NOvA doing at addressing the recommendations from the Fermi Director's/DOE Fermi Site Office's Performance Management System (PMS) Review needed for Baseline Development?

Out of the 10 recommendations, 2 are complete, 4 are in progress and 4 have not been addressed yet. The completed action are appropriate and the proposed actions for the in progress recommendations appear to be suitable. Resolution of all recommendations should be either completed or an action plan in place with a projected completion date by the time of the Lehman Review